JPRS-UMS-84-005

18 July 1984



# USSR Report

## MATERIALS SCIENCE AND METALLURGY



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# MATERIALS SCIENCE AND METALLURGY

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UDC 539.4

## EFFECT OF INGOT STRUCTURE OF FAILURE DUCTILITY OF PRESSED SEMIFINISHED PRODUCTS OF HIGH-DURABILITY ALUMINUM ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 84
(manuscript received 11 Aug 82) pp 25-28

ESKIN, G. I., NESHPOR, G. S., KOPELIOVICH, B. A., BOROVIKOVA, S. I., ARMYAGOV, A. A., BER, L. B. and PETROV, A. D., Kiev

[Abstract] Ultrasound processing of crystallizing fusions of industrial high-durability aluminum alloys with nucleus-type modifiers forms a fine structure with subdendrite grain, without branching. This structure makes it possible to increase plasticity greatly, regardless of hot shaping procedure or degree. The present article reports on the effect of the subdendrite structure on the structure and characteristics of the V96tsl (Al-Zn-Mg-Cu) alloy. Static durability, viscosity and hardness limits, true resistance to breaking, relative stretch and the coefficient of deformation tempering were determined by mathematical calculations and confirmed experimentally. Results showed that ultrasound processing retarded the rate of fatigue crack growth. The processed alloy had 45-55% higher coefficient of stress intensity, and was far more resistant to failure than unprocessed control samples. Figures 2; references 5: all Russian.
[92-12131]

UDC 620.17:620.18:669.715

## STRUCTURE-PHASE STATE AND PROPERTIES OF HIGH-DURABILITY VAL8 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, Mar 84 pp 51-53

POSTNIKOV, N. S., SHPIGEL', A. S., LUK'YANOV, G. S. and LAKTIONOVA, L. I.

[Abstract] The present article considers means of choosing alloying elements and their impact on overall properties of the resulting alloys by study of an Al-Si alloy with 8% silicon and varying amounts of Mg, Cu, Zn, Be, Ti and Zr. Analysis of copper and zinc by a microsounding method showed zinc to be in solid solution and independent of thermal processing, while the maximum copper content in solid solution with minimum amounts in other phases came with a 1% zinc content in the alloy. These two elements led to the greatest increase in

durability with the least change in relative stretching. A mathematical planning process was developed for showing composition-property relationships. Tests of other combinations of alloying elements showed various minor phase variations, the presence of oxidants around silicon crystals, and the stabilizing effect of beryllium on alloy oxidation. The basic properties of the VAL8 alloy of durability, viscosity, hydrodurability, plasticity, etc., were maintained. Figures 2; references 4: all Russian.
[87-12131]

UDC 669.715:539.43

MECHANISM AND PATTERN OF FATIGUE CRACK GROWTH IN ALUMINUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 84 (manuscript received 17 Oct 82) pp 159-163

SHANYAVSKIY, A. A. and KUNAVIN, S. A., Moscow

[Abstract] Fatigue crack growth in aluminum alloys is analyzed on the basis of the Elber model (ASTM STP, 486, 1981), specifically the second stage of crack opening in zone C (crevices) after longitudinal shear has initially built up in zone P (pseudocrevices) and before macroplastic instability will finally occur in zone PC (pits and crevices). The self-similar discrete process of crack growth jumps in successive loading cycles is described by the relation $\delta_i/\delta_{i+1} = \Delta^{1/m}$, with the universal fracture constant $\Delta = 0.22$ and $m = 4, 8, 16, 32$ for aluminum alloys. Also taken into account is the transition from stage I and to stage III. An experimental study made of D16T aluminum alloy cracking within the threshold range, with morphological and microstructural examination under a KVIK-100 microscope ($9 \cdot 10^{-6}$ mm resolution x $10^3$-$10^5$ magnification), has yielded quantitative data on crack increments as well as on corresponding threshold stress intensity coefficients $\Delta K_{1,thr}$ below which no cracking occurs and $\Delta K_1^{N-1}$ for transition from stage I to stage II. With at least one $\Delta K_{1,i}$ determined from $\Delta K_1^{N-1} = \sigma_0\sqrt{\pi L_{sII}}$ ($\sigma_0$-nominal stress, $2L_{sII}$- length of crack during I-II transition) and the minimum crack increment or fracture "quantum" known to be 23 Å, it was possible to plot the cracking pattern on a microrelief diagram for this particular aluminum alloy. Figures 3; references 16: 9 Russian, 7 Western.
[102-2415]

UDC: 669.716:621.74

DEVELOPMENT OF AK18 ALLOY PRODUCTION TECHNOLOGY BASED ON ELECTROTHERMIC SILUMIN

Moscow TSVETNYYE METALLY in Russian No 3, Mar 84 pp 50-52

KARPOV, B. I., MIKHAYLOVA, M. N., CHEL'TSOV, V. M., LEBEDEV, K. P. and BAYKINA, A. I.

[Abstract] The purpose of this work was to develop a technology for the manufacture of the piston alloy AK18 with high iron content with optimal modification. The initial charge materials included alloy AK18 (about 18% Si, 1.1% Mg, 0.5% Fe, 0.1% Ti, 0.2% Zr, 0.5% Cu and 1% Ni) produced from electrothermic silumin, an aluminum-iron (20% Fe) master alloy and type KR1 crystalline silicon, introduced to maintain a constant silicon content. The alloys were manufactured in a 30 kW resistance furnace in graphite-chamotte crucibles, refined with hexachloroethane 0.5% of the charge mass, introduced in aluminum foil. Some of the alloys were preliminarily refined with sodium-containing salts. The influence of the following modifying additives was studied: CuP, CuP+S, $CaC_2$, SiC, a patent additive consisting of 20% red phosphorus, 70% potassium chloride and 10% potassium fluorotitanate. Mechanical properties were determined on specimens poured into a cast iron chill mold after heat treatment. The results showed that preliminary refining with sodium-containing salts has no significant influence on the properties studied. As the content of iron in the alloy is increased from 0.4 to 0.7%, strength and hardness increase in both modified and nonmodified alloys, although ductility decreases slightly. The fluidity of the alloys remains rather high, characteristic for silumins of this composition. Based on the data obtained, technology was developed for commercial production of AK18 alloy, used at the DAZ plant to produce a pilot-scale batch of this alloy containing 0.7% iron.
[95-6508]

UDC 669.715:620.1

ESTIMATING DEFORMABILITY UPON PRESSING OF ALUMINUM ALLOYS BASED ON RESULTS OF MECHANICAL TESTING

Moscow TSVETNYYE METALLY in Russian No 3, Mar 84 pp 79-81

ZAKHAROV, V. V. and KUKUSHKIN, Yu. N.

[Abstract] Experimental data are presented representing the correlation between certain criteria suggested for use in estimating deformability and one of the major indices of deformability of aluminum alloys during pressing, the maximum permissible flow rate. Exceeding this flow rate causes defects on the surface of pressed semifinished goods, primarily cracks. The maximum permissible flow rate is a structurally sensitive characteristic, strongly depending upon chemical composition of the alloys and the structure of the pressed blanks. It is determined by the appearance of transverse cracks on

the surfaces of pressed semifinished goods. Based on the plan of crack formation suggested, factors can be distinguished which determine the critical flow rate. They include the difference between the temperature at which cracks begin to form and the temperature to which the blank is heated before pressing, as well as the mean rate of temperature rise in the pressed alloy during the pressing itself. The temperature rise rate is the stronger of the factors studied. It is most expedient to use deformation resistance, determined under the temperature and speed conditions of pressing, for approximate estimation of deformability during pressing of aluminum alloys. Figures 2; references 17: 14 Russian, 3 Western.
[95-6508]

## ULTRASONIC INSTRUMENT 'AKON-3' FOR NONDESTRUCTIVE TESTING OF METALS

Kishinev SOVETSKAYA MOLDAVIYA in Russian 16 Mar 84 p 4

[Article by B. Belen'kiy]

[Excerpt] An original ultrasonic instrument which makes it possible to determine the structure of metals has been developed at the All-Union Scientific Research Institute for the Development of Nondestructive Methods and Equipment for Testing the Quality of Materials (VNIINK).

This instrument bears the commercial name Akon-3 and the technical name US-13i, "US" being an acronym of 'ultrasonic structure analyzer'. Its dimensions are compact, it is finely crafted and, like any sophisticated instrument, it is surprisingly simple.

"One can peer into the depths of a metal with the aid of this instrument," said Ivan Arsen'yevich Kovrik, a senior science associate and head of a group of developers.

Metal lives in the process of operation, and changes take place constantly in its internal structure.

"They are there, and methods must be learned for determining them, in the interests of ensuring the reliability of equipment and selecting processes and, lastly, in the interest of safety," said I. Kovrik.

What was formerly done in such cases? Steel specimens, so-called control samples, were taken. They were studied under a microscope, the sizes of their grains were evaluated and they were classified and graded. In short, it was a long, complicated and not very reliable process.

It was then that the researchers turned their attention again to ultrasound. Studies carried out at a number of scientific organizations, including VNIINK, demonstrated that ultrasound is capable of not only recognizing and finding hidden flaws in materials but also of characterizing, with sufficient objectivity, the internal structure of metals and changes taking place in it.

A laboratory instrument developed on the basis of this research was demonstrated at the USSR Exhibition of National Economic Achievements and twice awarded medals. And now a new instrument has been developed. Science associates

V. Shinkarev and B. Mil'man and senior project engineer Yu. Shmurun took an active part in its development. Its main advantage is its lightness and convenience to use. One can also work with it in high places, which is a factor of no small importance, considering the complexity of the structures of many enterprises' equipment.

This year, the "Elektrotochpribor" (precision electronic instrument) plant of the "Volna" Production Association will produce the first industrial lot of these clever instruments, which the country's economy needs very much.

FTD/SNAP
CSO: 1842/106

UDC 621.793:621.7.044.2.001

## EFFECT OF SUBSTRATE SURFACE ROUGHNESS ON COHESIVE STRENGTH OF EXPLOSION-FORMED POWDER COATINGS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 84
(manuscript received 10 Aug 82) pp 117-118

KAUNOV, A. M., BUKIN, V. M. and SHAMREY, A. V., Volgograd Polytechnic Institute

[Abstract] In recent years shock wave applications of protective coatings have drawn increasing interest, although high-durability coatings over 100 mcm in thickness have been difficult to produce. The present article reports on explosive application of nickel powder to a rough-surface steel substrate. Results showed that the strength of coating bond grew in proportion to the rapidity of impact. Surface roughness was found to affect adherence, despite expectations. This is attributed to air compressed at the substrate surface, which is not effectively eliminated by the shock wave. Thus a clean, polished surface is more suitable for applying explosion-formed powder coatings. Figures 2; references 8: all Russian.
[93-12131]

UDC 621.763

## STUDY OF PHASE COMPOSITION OF Al-B PLASMA COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 84
(manuscript received 26 Jun 81) pp 68-70

AVLOKHASHVILI, Dkh. A., GABUNIYA, D. L., ZIL'BERG, V. G., KARPINOS, D. M., STASHEVSKAYA, I. A., TAVADZE, F. N., TAVADZE, G. F. and TSAGAREYSHVILI, G. V., Institute of Material Science Problems, Ukrainian Academy of Sciences; Institute of Metallurgy imeni 50th Anniversary of the USSR, Georgian Academy of Sciences

[Abstract] Aluminum specimens with a coating consisting of aluminum plus boron applied in air were studied to determine the possibility of applying coatings by plasma methods. Studies were made of sections prepared from central and peripheral portions of the plasma coated specimens. X-ray studies were performed using Cu radiation, nickel filter. Localized x-ray spectral analysis of specimens was also performed. It was concluded that during plasma atomization of the Al-B composite the boron powder underwent no structural changes. The plasma atomization method has the advantage of possibility of preparation and application of mixtures with various percent contents of the components as coatings. Figures 4; references 5: all Russian.
[98-6508]

COMPOSITE MATERIALS

## PROCESS FOR MAKING COMPOSITES WITH FIBER-REINFORCED ALUMINUM BASE

Minsk SOVETSKAYA BELORUSSIYA in Russian 11 Mar 84 p 2

[Text] The Belorussian Academy of Sciences' Physical-Technical Institute has developed production processes for obtaining composite materials with an aluminum base that has been reinforced with fibers of various metals.

A method for the continuous casting of wire compositions makes it possible to obtain materials that have different compositions and proportions of reinforcing elements. They can be employed in spraying processes for obtaining wear-resistant, heat-resistant, corrosion-resistant and other coatings. They are also recommended for use at plants for the production and reconditioning of aluminum pistons for diesel engines, and at other machine-building enterprises.

FTD/SNAP
CSO: 1842/106

UNIT FOR CONTINUOUS CASTING OF ALUMINUM-BASED COMPOSITE MATERIALS

Minsk SOVETSKAYA BELORUSSIYA in Russian 30 Mar 84 p 2

[Text] A continuous-casting unit for obtaining composite materials based on aluminum and its casting alloys has been developed at the Belorussian Academy of Sciences' Physical-Technical Institute. Boron, carbide and silicon fibers and fibers made of various metals can be employed as reinforcing elements.

Among the unit's principal assemblies are a reeling-out device, a metal receptacle, a mold, a cooling device, a drawing mechanism and a drum onto which the finished product is wound. The unit can have still other auxiliary assemblies, such as a bath for cleaning reinforcing fibers, a furnace for preheating them, etc.

FTD/SNAP
CSO: 1842/106

EXHIBITION OF COMPOSITE MATERIALS AND PRODUCTION TECHNOLOGY

Moscow EKONOMICHESKAYA GAZETA in Russian No 12, Mar 84 p 24

[Article by K. Kursov]

[Excerpt] An exhibition, "Composite Materials", has opened at the USSR Exhibition of National Economic Achievements. More than 200 models of products of 80 enterprises and scientific research institutes are being shown in this exhibition, as well as mock-ups of units for the production of progressive materials.

At the exhibition, one can see a considerable number of useful items and become familiar with experience in the use of composite materials in various branches of industry. Materials and processes which the Belorussian Academy of Sciences' Institute of Mechanics of Metal-Polymer Systems has developed for the manufacturing of wood-polymer shaped products are protected by certificates of invention. The main feature of these materials is that they are obtained from waste products of lumber milling. They can be broadly utilized in machine building and construction. Rolivsans--materials from the USSR Academy of Sciences' Institute of Macromolecular Compounds (Leningrad)--are unique from the standpoint of thermal resistance and strength. They are beginning to be used primarily in environments where temperatures range from minus 190 to plus 320 degrees.

Scientists of the Graphite Scientific Research Institute have developed a progressive material called uglevoloknit. It is becoming indispensable in the production of heat exchangers and centrifugal pumps. The effectiveness of this innovation is indicated by a single fact cited in the display: the manufacturing of pumps from uglevoloknit saves 20 kilograms of high-alloy steel per pump.

The exhibits in the exhibition are diverse and give an idea of the directions in which the efforts of scientists and industrial specialists are proceeding. It begins with the development of highly effective composite materials and industrial units for obtaining them and ends with the broad introduction of products with prescribed properties in machinery.

One original unit is intended for obtaining composite materials by hot molding, for example. It was proposed by the Urals Polytechnical Institute and is already being used at a number of enterprises of the Ministry of Power Machine

Building. An operating mock-up of this unit is on display at the exhibition. Experience has demonstrated the unit's advantages over other models. They lie in its combined heating system, which allows the necessary temperature to be maintained, and also in its system for programmed control of the process' main parameters. The economic effect from the utilization of the unit is 550,000 rubles a year.

The exhibition will end in October.

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CSO: 1842/106

UDC 539.4

NEW METHOD FOR STUDYING SURFACE CRACK GROWTH IN LAMINATED POLYMER COMPOSITE MATERIALS

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 1, Jan-Feb 84 (manuscript received 29 Mar 83) pp 84-87

CHAPLYA, M. E. and GVOZDYUK, N. M., Physicomechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences, L'vov

[Abstract] The durability of laminated polymer composite materials has encouraged wide use as well as numerous scientific studies, but most have concentrated on samples 10 mm+ in thickness. The present article reports on study of samples less than 5 mm in thickness to develop a methodology for studying crack resistance. Three-layer samples with initiated flaws were stretched as lengthening of the sample and crack expansion were recorded. The samples consisted of a homogeneous center laminate with PMMA outer layers attached with related polymerizing glues. The apparatus used and the course of stretching and cracking is summarized. Analysis of the fracture surface indicated a process like that of organic glasses, with a failure focus and a mirror zone, the development of which is a key feature in determining cracking direction and nature. The dimensions of the fissure apparently depend on the precritical growth of the crack in the first laminate. Critical coefficients vary, with resistance decreasing when various additives are included in the test fiberglass sheets. Temperature of polymerization is not as important as the additives used. Figures 4; references 10: all Russian.
[86-12131]

UDC 539.3

EVALUATION OF RESIDUAL STRESS IN LAMINATED METALLIC COMPOSITES

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 84 (manuscript received 16 Dec 82) pp 85-88

KAZAKOV, N. F., SERGEYEV, A. V., STEPANOVA, N. I. and KHARITONOVA, A. N., Moscow Institute of Aviation Technology

[Abstract] Bimetals and multi-laminate composition materials are finding numerous applications in modern technology. Production and joining problems

continue to offer difficulties. In welding, cooling often leads to loss of form or delamination. The present article reports on an analytical approach to resolving such problems. Calculations were based on a linear tempering process, with cooling from the welding temperature to 293°K. The calculated values were then tested experimentally with a trimetal of 12Ch18Ni10Ti steel-copper-molybdenum and a VT10 titanium-aluminum bimetal, with thicknesses of components in the bimetal at 2, 0.5 and 2 mm (forming a sandwich) and with nine 0.5 mm layers in the trimetal. The experimental data agreed with the calculations and permitted the authors to determine temperature regimes that reduce residual stress after welding. For the trimetal, the temperature range was 500-700°K. References 3: all Russian.
[93-12131]

UDC 539.4:678.067

THEORETICAL AND EXPERIMENTAL STUDY OF CRACK RESISTANCE AND MACROCRACK GROWTH RATE IN ORGANIC FIBER REINFORCED PLASTIC UNDER PURE SHEAR CONDITIONS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 84 (manuscript received 4 Mar 83) pp 149-152

ZAYTSEV, G. P. and KAYKOV, K. V., Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy

[Abstract] Dealing with highly dangerous cracks in design components requires evaluation during manufacture as well as later monitoring. Little previous study has been made of such cracks; this article seeks to fill that gap. Pure lateral shear from the reinforced structure, initial length and orientation of cracks are discussed. A two-parameter mathematical model was developed to illustrate the linear mechanics of failure with correction in the pre-failure crack surfaces. Failure calculations were made using a consecutive approximation method, and a photorefractory coating method was used to evaluate the stressed state in the organotextolite layer during lateral shear. The coating was an epoxy resin with metaphenyldiamine hardener. The experimental data made it possible to perfect the mathematical models and make them much more accurate. Results showed that the spread of cracks is dependent on structure type and orientation relative to the basic reinforcing direction. Figures 3; references 4: 2 Russian, 2 Western.
[88-12131]

UDC 624.074.001:678.067

## PREDICTING STABILITY OF FULL-SCALE COMPOSITE CONSTRUCTIONS ON THE BASIS OF STIFFNESS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 84
(manuscript received 22 Mar 83) pp 124-130

KARTASHOV, G. G., TKACHENKO, S. I. and KOMAROVA, O. A., Kuybyshev Aviation Institute imeni Academician S. P. Korolev

[Abstract] The range of technical features of large composite designs requires careful experimental study before use in order to establish technical and economic parameters. The present article reports on calculation of durability for various composite designs and on prediction error of load ratings. Simple models were developed in order to compare calculated and experimental values for hinged orthotropic and sloping cylindrical panel designs. Descriptions are given of a channel, a conical shell, and a cylindrical shell. The study shows that the use of the stiffness factor selected permits sufficiently accurate prediction of components made of composite materials for durability testing. The use of two-component prediction reduced prediction error by 2—3.7 times compared to a single-component formula. In some cases, a layer-by-layer evaluation was required. Figures 4; references 14: 11 Russian, 3 Western.
[88-12131]

UDC 539.4:678.067

## INITIAL FRACTURE STAGES OF ORTHOGONALLY REINFORCED COMPOSITE MATERIAL

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 84
(manuscript received 1 Jun 83) pp 60-66

UPITIS, Z. T., BUYLIS, I. V., KRAUYA, U. E. and KULIK, V. I., Institute of Polymer Mechanics, LaSSR Academy of Sciences, Riga; Leningrad Mechanical Institute

[Abstract] Studies of strength during plane tension usually emphasize the final state of the material tested, but failure is actually a gradual weakening process. Composite materials with longitudinal and lateral laminating have been studied in depth, and the nature of their failure determined to be lateral to the force field line of the composite. The present article reports on experiments with orthogonally reinforced fiberglass-carbon fiber material during stretch along the generatrix, with reinforcing fibers of "VNMS" glass and "VMN-RK" carbon roving. Processes for producing the test material are summarized. Despite expectations, the kinetics of light impulses indicate that redistribution takes place both within a laminate layer and between laminates in a gradual process that precedes total failure. With a more complex loading procedure, mechanoluminescence tests showed crack formation through the transparent outer fiberglass layer very early in the failure process. Figures 4; references 17: 15 Russian, 2 Western.
[88-12131]

UDC 539.4:678.067

## STRENGTH PROPERTIES OF UNIDIRECTIONALLY REINFORCED HYBRID COMPOSITES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 84
(manuscript received 1 Jul 83) pp 35-41

MAKSIMOV, R. D., PLUME, E. Z. and PONOMAREV, V. M., Institute of Polymer Mechanics, LaSSR Academy of Sciences, Riga

[Abstract] Laminate analyses using phenomenological strength criteria have established a correspondence of calculated and experimental data for a plane tension state. The present article reports on experimental study of unidirectional composites with a polymer binder and two types of glass, carbon, organic and boron fibers, determining short-term strength as a function of type and fiber content, the possibility of describing strength in a plane tension state, and assessment of surface tensor strength based on fiber volume in a given composite. The hybrid composites tested included organic-glass-plastics, organic-carbon-plastics, organic-boron-plastics and carbon-glass-plastics. The calculations for quasi-static loads show the possibility of using phenomenological strength descriptions with plane tension state to measure components of surface strength tensors by a polynomial criterion. The results can be used to predict durability of a given fiber composite type to fit purposes and optimize use of materials. Figures 8; references 15: 14 Russian, 1 Western.
[88-12131]

## HIGH-STRENGTH COMPOSITE MATERIALS FOR AIRCRAFT, BODY ARMOR

Vilnius KOMSOMOL'SKAYA PRAVDA in Russian 12 May 84 p 3

DOVIDENAS, V., docent

[Abstract] The author surveys progress in the USSR and abroad in applications of composite materials for transportation and industry. Particular attention is devoted to the technical and economic advantages of extra-strong and light-weight glass-reinforced and carbon-fiber-reinforced plastics which have been developed for aircraft, spacecraft, ships and motor vehicles. The author notes that composite materials are being designed for the production of such key parts of aircraft as airplane fuselage frames and stern-propeller shafts of helicopters. Specific information is related on the use of composites in glider plane construction. A record-setting glider, the "Letuva", which was first built in 1972, is said to be made almost entirely of composite materials. Wing spars up to 12 meters long for the "Letuva" are manufactured from a carbon-reinforced plastic at the Prenay Sports Aviation Experimental Plant, which has pioneered the introduction of all-plastic reinforced structures in the USSR. The plant has special units for hardening composites at high pressures and temperatures. Also mentioned is the use of kevlar fibers in bullet-proof vests.

FTD/SNAP
CSO: 1842/106

UDC 620.178.167.3:620.191.33:669.868

METHOD OF CONSTRUCTING DIAGRAM OF BIMETAL FATIGUE FAILURE

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 1, Jan-Feb 84 (manuscript received 24 Jan 83) pp 104-106

MAKHUTOV, N. A., CHERNYAYEV, A. P. and TANANOV, A. I., Machinebuilding Institute imeni A. A. Blagonravov, USSR Academy of Sciences, Moscow

[Abstract] Expanded use of bi- and multi-laminate metallic compositions with complementary physicomechanical properties requires more precise evaluation of load capability with crack-type defects and prediction of useful life based on knowledge of components of the laminated material. The present article presents calculations of these dynamic fatigue failure parameters, and results of experimental confirmation of the theoretical values, using a bimetal St.3+12Ch18Ni10T steel made by fagot rolling. The tests indicated that the mathematical model data were within an acceptable 15% of the experimental findings. Figures 3; references 3: all Russian.
[86-12131]

UDC 677+427:620.172

EVALUATION OF FEATURES OF REINFORCING FIBERS BY TESTING BUNDLES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 84 (manuscript received 18 May 83) pp 3-7

ABRAMCHUK, S. S., YERMOLENKO, A. F. and PROTASOV, V. D.

[Abstract] Shortcomings of standard tests for fiber deformation and durability led the authors to develop the present model to assess inequalities of fiber load, distribution of durability in the transition from one bundle to another, failure point and length variations. Mathematical formulas are presented to express the relationship between stretch tension and deformation for bundles of many fibers where loading onto individual fibers or their failure do not cause major variations. Mathematical data showed an initial non-linear segment related to unequal load initiation on fibers; length variation dispersion did not exceed 0.1%. Figures 3; references 2: both Russian.
[88-12131]

UDC 669.018:95:621:771:669.24'29

## INFLUENCE OF PLASTIC DEFORMATION ON STRUCTURAL STABILITY OF NICHROME-TUNGSTEN COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 84
(manuscript received 28 Dec 82) pp 40-44

KARPINOS, D. M., TUCHINSKIY, L. I., VISHNYAKOV, L. R., MOROZ, V. P., DZEGANOVSKIY, V. P. and BONDARENKO, T. N., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] Results are presented from a study of the structure of a sandwich-type unidirectional composite material obtained by hot stamping. Studies were performed on KhN60VT and KhN78T alloys reinforced with VA tungsten wire 0.1 mm in diameter. Reinforcement percentages were 28% for KhN60VT, 24% for KhN78T. Plastic deformation by rolling caused the fibers to elongate, taking on a near elliptical shape. Studies of chromium distribution showed that in both composites during annealing the chromium concentration at the surface of the specimens decreased to 0.5-2% by mass in a layer 60 to 80 μm thick. The materials, obtained by hot stamping and subsequent plastic deformation, showed variation in the nature of diffusion interaction of the components as a function of the degree of plastic deformation. The tungsten fibers stabilized the composition of the composite, presenting obstacles to diffusion of chromium. Figures 5; references 6: 5 Russian, 1 Western.
[98-6508]

UDC 621.922.079:621.762

## STRUCTURE AND PROPERTIES OF COPPER-TITANIUM-ALUMINUM COMPOSITES OBTAINED BY THERMOREACTIVE SINTERING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 84
(manuscript received 24 Aug 83) pp 53-56

DELEVI, V. G., BURKHAN, A. A., KONAVALOV, V. A., TKACHENKO, R. K., PISARENKO, N. V., BAGNO, N. G. and CHEREPENINA, Ye. S., Institute of Superhard Materials, Ukrainian Academy of Sciences

[Abstract] The purpose of this work was to study the structure and properties of composites in the system Cu-Ti-Al obtained by thermoreactive sintering. Compositions were selected with constant mass content of aluminum (5%) and variable copper and titanium contents (5-60%) at intervals of 5%. Studies were performed by metallography and measurement of microhardness, x-ray phase and microscopic x-ray spectral analysis, testing for compressive and bending strength, specific impact toughness and aggregate Rockwell hardness. The process of formation of composites in the system is a diffusion process, resulting in a formation of microstructures consisting of various intermetallic compounds and residues of the initial components. As the titanium content in the composite changes, both quantitative and qualitative structural changes occur.

The most homogeneous structure is that of composites with 35-45% Ti, the end products of which contain the minimum quantity of the initial components. Composites with 15 to 30% Ti have relatively good physical and mechanical properties. These compositions can be recommended as a metallic matrix for the operating layer of abrasive tools made of superhard materials. Figures 3; references 6: 5 Russian, 1 Western.
[98-6508]

## CONFERENCE ON POWDER-METALLURGY METHODS FOR STRENGTHENING MACHINE PARTS

Tashkent PRAVDA VOSTOKA in Russian 8 May 84 p 1

[Abstract] The article summarizes proceedings of a conference on the protection of machine parts against wear using methods of coating and hard-facing with wear-resistant powders. The conference, which ended in Navoi on May 7, adopted recommendations aimed at promoting the broad industrial utilization of experience with reconditioning and strengthening methods of this type. The advancement of this work was called highly important for the strengthening of the USSR's economic and defense potential. Brief summaries are given of introductory remarks by G. I. Marchuk, vice-chairman of the USSR Council of Ministers and chairman of the USSR State Committee for Science and Technology, and of a speech by I. B. Usmankhodzhayev, first secretary of the Central Committee of the Communist Party of Uzbekistan. While hailing progress in the introduction of powder-metallurgy methods in the Uzbek republic, Usmankhodzhayev mentioned that possibilities exist here for increasing by four to five times the production of hard-alloy tools and the reconditioning of parts by these methods, as well as the employment of products made from metal powders. Other government and Party officials, prominent scientists and representatives of industry who took part in the conference are identified. Among them were A. P. Aleksandrov, president of the USSR Academy of Sciences, academician B. Ye. Paton, president of the Ukrainian Academy of Sciences, and academician A. S. Sadykov, president of the Uzbek Academy of Sciences.

FTD/SNAP
CSO: 1842/106

UDC 629.735.33.024.015.4:620.193

# FORCED CORROSION TESTS OF CONSTRUCTION COMPONENTS OF PASSENGER AIRCRAFT FUSELAGES

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 1, Jan-Feb 84 (manuscript received 29 Sep 82) pp 92-93

KARLASHOV, A. V., GAYNUTDINOV, R. G., SVINTSITSKIY, A. M., VORONKIN, N. F., SADKOV, V. V., VORONOV, V. F. and KRASNOV, Ye. A., Kiev Institute for Civil Aviation Engineers

[Abstract] Natural tests are the most common way of evaluating corrosion of design components and protective coatings in aircraft, but accelerated laboratory tests are effective for predicting useful life if coefficients for transforming accelerated wear values into actual ones exist. The present article reports on an attempt to determine the nature of changes in the coefficient of corrosion acceleration as dependent on test duration for V95 aluminum used in aircraft fuselages, taking into account both atmospheric and condensational factors that can provoke delamination. Tests with 1.0 g/l potassium dichromate and 1.0 ml/l hydrochloric acid indicated that this solution effectively reproduced the delaminating corrosion on fuselage stringers, as measured by loss of fatigue resistance. Results showed that natural condensate cut longevity by 57% in 20 days, while the accelerated solution cut it by 74%. In the next 20 days loss of useful life decreased by an additional 10% and 4%, respectively. Thus in general, results indicated that the coefficient of forced corrosion decreased with increasing duration of testing. This factor must be considered in assessing results received in accelerated corrosion tests. Figures 2; references 8: 7 Russian, 1 Western.
[86-12131]

UDC 669.295:539.4.019.3

# OXIDATION OF PT-7M AND OT4-1 TITANIUM ALLOYS IN AIR

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 1, Jan-Feb 84 (manuscript received 23 Feb 83) pp 87-91

MAKSIMOVICH, G. G., FEDIRKO, V. N. and LIZUN, A. T., Physicomechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences, L'vov

[Abstract] Wide disagreements exist concerning the effects of alloying agents on titanium oxidation. The present article reports on gas corrosion of industrial titanium alloys with aluminum, zirconium and manganese at 850°C, in comparison with technically pure VT1-0 titanium. The structure of oxide layers, studied metallographically, by absorbed electron methodology and visually, show more intensive scaling in the alloyed than in the pure titanium samples, with a compact "basalt" external oxide and a powdered inner oxide at the metal-oxide boundary. Structural analysis indicated that the oxides formed were more resistant to etching agents than the remaining metal. Aluminum increased scale formation at first, then reduced solution of oxygen in the metal and, with the formation of an $Al_2O_3$ layer, increased heat resistance. Alloying with 2% Zr resulted in a thicker layer of scale, but less depth of oxygen diffusion. Manganese also increased the rate of scaling, but the depth of gas saturation in the alloy increased. Figures 2; references 9: 7 Russian, 2 Western. [86-12131]

UDC 535.241.4

## ANALYSIS OF PHASE COMPOSITION OF PRODUCTS OF LASER DESTRUCTION OF METALLIC SURFACES

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1, Jan 84
(manuscript received 14 Jun 82) pp 51-53

VEYKO, V. P., ROGOVAYA, N. I. and TUCHKOVA, Ye. A., Leningrad

[Abstract] Recently attempts have been made at vaporizing refractory metals in a vacuum in order to obtain thin coatings, but success has been hampered by the "splash effect." The present article reports on theoretical consideration of phase structure resulting from use of a laser impulse of about $10^{-8}$. Mathematical formulas were prepared for heating, melting, vaporizing and removal of the melted material from the irradiated zone. After running the resulting program on a computer, experimental tests were conducted for verification with a molybdenum target and surface intensity of about $10^{13}$ watt/$m^2$. The course of laser melting and vaporization indicated that the portion of liquid phase metal could exceed that of the vapor phase, while increasing laser intensity brought increased liquid phase amounts. Decreasing the impulse duration brought an increase in the general amount of products of laser destruction, while reducing the dimension of the irradiated zone sharply increased the quantity of melted metal. Figures 4; references 5: all Russian.
[90-12131]

UDC 621.375.826:621.785(47)

## RESIDUAL STRESS AFTER LASER PROCESSING

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1, Jan 84
(manuscript received 12 Apr 83) pp 29-32

GRECHIN, A. N. and KATOLICHUK, V. A., Moscow

[Abstract] Rapid heating and cooling and phase changes during laser processing of metals produce residual surface stress. The present article reports on study of distribution of such stress in ferrite and perlite forged irons and 45 and U10 steels with and without surface melting. Before processing, the samples were annealed at 700°C for 2 hours and treated with manganese phosphate to enhance surface absorption. Pulsed and continuous beam lasers were used.

Pulsed processing of the ferrite without melting brought compression pressure that decreased only at a depth of 0.3 mm. Such internal stress was not found in samples where the laser irradiation caused melting. Similar results came with continuous beam laser processing, and results with perlite iron were analogous but with much more extreme internal stress values. In the steels tested, the tension was not of a compression but of a tractive type, regardless of the type of laser irradiation used. Laser tempering affected deformation of samples on the basis of both the radiation procedure and the intensity of the path. Consecutive passes with the laser did not bring as great an increase in internal stress as anticipated. Figures 2; references 3: all Russian.
[90-12131]

UDC 669.11:530.145:535.8

STUDY OF MICROSTRUCTURE OF ALUMINUM AND COPPER ALLOYS AFTER PROCESSING WITH CONTINUOUS $CO_2$ LASER BEAM

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1, Jan 84
(manuscript received 5 Dec 82) pp 26-29

SAFRONOV, A. N., GRIGOR'YANTS, A. G., MAKUSHEVA, N. A. and SERGEYEV, A. V.

[Abstract] Effects of laser irradiation on surface layers of steels and irons have been described in some detail, but effects on non-ferrous metals have received less attention. The present article reports on structural changes in surface layers of various aluminum alloys with laser processing at 1-3 KWT, depths of 0.32 to 0.85 mm and beam width of 1.6-2.4 mm. Variations in resulting microhardness are discussed. The tempered zone that developed in iron and steel alloys after laser treatment was found lacking in the aluminum alloys tested. Impurities changed form from acute-angled and needle-shaped forms (e.g., of silicon) to globular and smooth-grained ones. With copper alloys as well as the aluminum ones, where nearly eutectic composition was found initially, microhardness was increased by 1.5--2 times during $CO_2$ laser irradiation. Figures 3; references 6: all Russian.
[90-12131]

UDC 621.762.5:620.187

## FORMATION OF STRUCTURE OF LANTHANUM HEXABORIDE IN PROCESS OF ELECTRIC IMPULSE HIGH PRESSURE SINTERING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 84
(manuscript received 21 Jun 82) pp 36-41

VOLKOGON, V. M., PADERNO, V. N., MARTYNENKO, A. N., PADERNO, Yu. B. and DUBOVKA, G. V., Institute of Problems of Materials Science, UkSSR Academy of Sciences

[Abstract] Study of structural changes related to producing refractory articles offers promise for developing materials with preset properties. The present article reports on a cylinder-piston high-pressure chamber permitting simultaneous pressure of 2.5-3 MPa and electrical charge of 4.0-12.5 MWT. The temperature generated, as gauged by tungsten foil during the tests, reached about 4000°C. Since lanthanum hexaboride has little low-temperature plasticity, immediate fracturing occurred at granule boundaries and sub-granular faults. With up to 6.3 MWT of current, an irregular banded fissured structure emerged. Little change occurred up to 10.6 MWT, although new fractures parallel to the load and oriented away from the high-pressure planes appeared. Some alloying with cylinder material was noted during electrical discharge. Figures 6; references 9: all Russian.
[84-12131]

UDC 621.762.5

## KINETICS OF SINTERING POROUS FIBERED BODIES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 84
(manuscript received 6 May 83) pp 41-45

KOSTORNOV, A. G. and GALSTYAN, L. G., Institute of Problems of Materials Science, UkSSR Academy of Sciences

[Abstract] Studies of sintering of porous articles with metallic fibers have revealed such features as volume increase due to elastic after-effects and the relaxational nature of reverse deformation, but control of volume changes has not been accomplished. The present article reports on sintering of cylindrical samples containing 1Ch18N9T stainless steel fibers, produced by liquid matting with heating in a vacuum dilatometer from room temperature to 1310°C, heat maintenance for 0.5 hour, and subsequent cooling. The nature

of volume growth was then assessed by independent determination of coefficients of thermal expansion of previously sintered samples. Others had concluded that samples of low porosity expand less during heating then those with high porosity. In the present tests, the motivating force of the final relaxational process for residual tension in fibered pressings was determined to be thermal expansion of individual fibers during heating of briquets, with maximum growth at about 850°C for all samples, regardless of porosity. The complex process of compression, deformation and growth in volume is outlined. Key parameters in determining the course of the process are porosity, relation of fiber length to diameter, module of elasticity of the fiber material, and temperature and duration of sintering. Figures 2; references 10: all Russian.
[84-12131]

UDC 543.33

KINETICS OF COMPACTING WURZITE BORIC NITRIDE DURING HIGH-PRESSURE HOT PRESSING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 84
(manuscript received 14 Mar 83) pp 31-36

KOVAL'CHENKO, M. S. and DZHAMAROV, S. S., Institute of Problems of Materials Science, UkSSR Academy of Sciences

[Abstract] Superhard polycrystalline materials used for cutting, produced by hot pressing under high quasihydrostatic pressure, have received little attention from the point of view of the kinetics and formation processes involved. The role of desorbed gasses in offering counterpressure is one of the neglected topics treated in the present article, which reports on hot pressing of wurzite boric nitride in a regulated high pressure chamber. Pycnometric study of the pulverized product indicated that the theoretical hardness was not achieved in the experiment. Consequently, the equation for hot isostatic pressing was modified to reflect the experimental results at 2070°K and 6.6 and 7.7 HPa of pressure. The role of desorbed gasses was shown to be a major factor in preventing the anticipated hardening. A rheological description of density kinetics takes this counterpressure into account. A nonlinear feature is related to granule boundary slippage of the initial powder structure. Figures 3; references 13: 12 Russian, 1 Western.
[84-12131]

UDC 669.017.3

## THERMAL EFFECT OF NUCLEATION DURING CRYSTALLIZATION OF METALLIC GLASSES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 84
(manuscript received 16 Feb 83) pp 92-95

TSAREV, G. L. and VOLOSHIN, Yu. N., Belorussian Republic Scientific Production Association for Powder Metallurgy, Belorussian Polytechnic Institute, Physicotechnical Institute, BSSR Academy of Sciences

[Abstract] A number of works on crystallization of metallic glasses note that microcalorimetric curves of heat release show an endothermal effect that precedes the fundamental exothermal crystallization effect. The present article reports on study of the physical nature of this process using an amorphous $Fe_{40}Ni_{40}P_{14}B_6$ alloy, which was annealed in a scanning microcalorimeter to 678°K. X-ray diffraction was used as well to determine three key results of the experiment: the presence of microcrystals in the glass-formation zone of the sample, the negative thermal effect and the marked temperature interval between the start of microcrystal formation and full crystallization. Calculations showed that in nucleation, surface pressure somewhat reduced the degree of superheating needed to form critical nuclei. Next, surface pressure on particles became single-phased and affected the growing crystal. Finely dispersed powders with great surface tension were recommended for increasing surface resistance of alloys used for these metallic glasses. Figures 2; references 7: 5 Russian, 2 Western.
[84-12131]

UDC 614.838.44.677.533.017.56:536.468

## EXPLOSION-PROOF PROPERTIES AND HYDRAULIC RESISTANCE OF FIRE-BARRIER ELEMENTS BASED ON KNITTED METALLIC SCREENS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 84
(manuscript received 23 Mar 83) pp 101-104

EL'NATANOV, A. I., STRIZHEVSKIY, I. I., RUTKOVSKIY, A. Ye., GEYNTSE, N. S., ZORIN, V. A., ANDREYEVA, N. V., IVANCHUK, A. A. and KARPINOS, D. M., Institute of Problems of Materials Science, UkSSR Academy of Sciences; State Scientific Research and Planning Institute for Nitrogen Production and Products of Organic Synthesis

[Abstract] Porous knitted metallic screens with relatively even pore distribution and insignificant hydraulic resistance have been found useful in explosion and fire barrier applications. The present article reports on such materials in analyzers of burning gas mixtures, taking into consideration pore dimensions, thickness and effectiveness in flame extinguishing, as well as the impact of geometric form on repeated use as a barrier to the shock wave caused by initial ignition. Critical pressure tests were made in a 100-mm vessel

divided into chambers of 0.1 and 3.5 l, the latter serving as the receiver in case of ignition in the smaller, and for controlled burn of the mixture. Induction receivers indicated that little transfer of combustion products occurred. Test screens with steel wire of 50-90 mcm diameter, with strands of 6-20 fibers of 50 mcm diameter and a combination of these, and 4-8 mm thickness, were covered with knitted stainless steel material of 0.4 diameter; pores were 0.5 x 0.5 mm. Results indicated that samples of 400-300 mcm porosity underwent significant deformation, yet still served as flame barriers. Fine wire strands were more effective than thicker ones, and rust from oxidation increased hydraulic resistance. Figure 1; references 3: all Russian. [84-12131]

UDC 621.763.536.2

## THERMOPHYSICAL PROPERTIES OF POROUS FIBER MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 84
(manuscript received 11 Mar 83) pp 88-92

KOSTORNOV, A. G. and GALSTYAN, L. G., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] An experimental study was performed of the combination of thermophysical properties (heat and temperature conductivity, heat capacity, coefficient of thermal expansion) of porous fiber materials. Heat conductivity was studied by a stationary comparison method, the "plate" method, a pulsed method based on studies of the kinetics of changes in temperature at one end surface of the specimen after a thermal impulse was applied to the other end, and the absolute method under conditions of steady heat flux along the axis of cylindrical specimens and through the wall thickness of sleeves. Heat conductivity decreased with increasing fiber diameter, as was expected. Heat conductivity changed with increasing temperature just as it changes in nonporous metals. Coefficients of thermal expansion varied with temperature in a manner which becomes understandable considering the fact that as porosity increases the distance between contacts and flexibility of elements increase, thus increasing the possibility of structural deformation in the material. Figures 3; references 15: 10 Russian, 5 Western.
[98-6508]

# IMPROVEMENT IN REFRACTORY MATERIALS FOR STEEL FURNACES

Moscow IZVESTIYA in Russian 23 Apr 84, p 1

[Article by E. Matskevich, correspondent (Aktyubinsk)

[Text] The Aktyubinsk Chromium Compounds Plant has completed installation of a line for industrial production of components of extra-stable refractory materials necessary for melting high-grade alloy steels in a vacuum.

This steel is used widely at plants that build power machinery, and refractory products of heightened stability also are very necessary in the chemical industry and ferrous metallurgy. At 1,100 to 1,200 degrees, the temperature 'ceiling' of domestic refractory materials made from local chromium ore has not been entirely satisfactory for metal producers. The raw material contains low-melting impurities that do not withstand higher temperatures. Therefore it has been necessary to import a considerable amount of this material, which is essential for metallurgical processes.

With the assistance of scientists from the Urals Chemical Scientific Research Institute in Sverdlovsk, specialists of the Aktyubinsk plant have obtained a new product. Being the main ingredient of refractory brick, it has permitted its thermal stability to be raised to 2,300 degrees. Units which utilize this material make it possible not only to intensify the melting of high-grade steel, but also to prolong the service life of the units themselves and to save a considerable amount of raw material and electricity.

FTD/SNAP
CSO: 1842/106

## PROCESS FOR OBTAINING NON-TUNGSTEN HIGH-SPEED TOOL STEEL

Vilnius SOVETSKAYA LITVA in Russian 24 Apr 84 p 3

[Text] Can drills and milling cutters be manufactured from high-speed tool steel which contains no strengthening tungsten?

Associates of the Azerbaydzhan Academy of Sciences' Institute of Physics and scientists of the Moscow Higher Technical School imeni Bauman and the Central Scientific Research Institute of Ferrous Metallurgy imeni Bardin have jointly developed original principles and methods for the heat hardening of steel and for imparting other necessary properties to it.

The scientists discovered the possibility of achieving an effect similar to alloying by changing the chemical composition of strengthening particles which are released from the metal in the course of the melting, quenching and tempering of steel, and also by sharply reducing the size of these particles. Whereas formerly they resembled large 'splinters' in the steel, these inclusions can now be broken down into numerous tiny particles. The metal's structure is thereby strengthened substantially.

Economists have concluded that the price of the new steel is one-half that of earlier kinds with similar characteristics. At least 60 kilograms of tungsten per ton of steel is saved.

FTD/SNAP
CSO: 1842/106

NON-TUNGSTEN STEEL FOR DRILLS, CUTTING TOOLS

Baku VYSHKA in Russian 31 Mar 84 p 3

[Text] Can drills and milling cutters be manufactured from high-speed tool steel which contains no tungsten? After all, this metal is now scarce, and reserves of it in the world are sharply diminishing; at the same time, steel is weaker without it. It turns out that costly tungsten can be saved for other purposes and that economical alloy steels can be manufactured without it, without worsening the quality of these steels. This possibility has been discovered by associates of the Azerbaydzhan Academy of Sciences Physics Institute and its metals science design-and-technological bureau "Kristall." They carried out joint research with scientists of the Moscow Higher Technical School imeni Bauman and the Central Scientific Research Institute of Ferrous Metallurgy.

The new steel is 50 percent less costly, and up to 60 kilograms of tungsten is saved per ton of steel melted.

FTD/SNAP
CSO: 1842/106

UDC 669.782+669.295:620.17:669.14.018.2

# EFFECT OF SILICON AND TITANIUM ON MECHANICAL PROPERTIES OF Ni18Co9Mb5Ti STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, Mar 84 pp 42-44

KHARITONOV, V. A., POPOVA, N. I. and SHISHOV, V. F.

[Abstract] Since silicon is a harmful impurity in Ni18Co9Mb5Ti martensite-aging steel and content must be controlled, the authors studied a range of 0.08% to 0.93% silicon content in tempered and aged samples of the steel to determine mechanical properties. Results indicated that as silicon content increased, limits of yield and durability increased somewhat, while plasticity and especially impact strength declined with normal tempering at 820°C in air or water. With tempering at 1000°C in water, impact strength increased with added silicon in the range 0.26-0.93%, but remained less than impact strength with 0.08% silicon content. Granule etching intensity in a 2% $HNO_3$ solution was in direct relation to silicon content and in inverse relation to the tempering temperature. Aged samples had markedly lesser plasticity and impact strength with higher amounts of silicon. Tempering at 1000°C in water had the same impact on aged samples as above. Titanium content of 0.43-1.65% was also tested for impact on mechanical properties. Ti content above 1.2% reduced the temperature interval of martensite conversion. As titanium content increased, durability of aged steel grew, while contraction, stretching and impact strength declined. Residual austenite reduced the effectiveness of tempering. Figures 1; references 6: 3 Russian, 3 Western.
[87-12131]

UDC 620.178.3

## FRACTOGRAPHIC FEATURES OF TITANIUM ALLOY FATIGUE FAILURE UNDER REPEATED STATIC STRESS AND HIGH FREQUENCY VIBRATION

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 84
(manuscript received 1 Apr 83) pp 81-85

YAKOVLEVA, T. Yu., VOZNYY, T. S. and KUZ'MENKO, V. A., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Durability of construction materials subjected to variable loads and cyclic frequencies ranging to 1000 Hz has received recent attention due to numerous applications of this nature. The present article reports on TS alpha-alloy and VT14 alpha+beta-alloy sheets tested with 500-Hz vibrations and a stretching load. Results showed a marked weakening effect with rather low-power, high-frequency vibration, but the damage was not as great as that resulting from corresponding low-frequency cyclic stress. Fractographic study of the same samples with repeated static stretch loading at 615 MPa without vibrations showed fatigue failure that was not attributable to "plate shifting." Analysis of VT14 high-durability titanium alloy samples showed similar fatigue destruction with both types of loading; failure was close to quasistatic in character. Some delamination along and lateral to the rolling axis was also noted in the VT14 alloy. Figures 4; references 6: all Russian.
[93-12131]

UDC 669.295.5.017:669.785

## EFFECT OF HYDROGEN ON FATIGUE OF VT6 ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 84
(manuscript received 12 Aug 82) pp 73-76

MAL'KOV, A. V., KOLACHEV, B. A., MISHANOVA, M. G. and BYLOV, B. B., Moscow

[Abstract] Varying loads on crucial parts of titanium alloys place great importance on study of fatigue resistance, but results have been contradictory. The present article reports on an attempt to define the effect of hydrogen on durability after its introduction by a thermal diffusion method with full annealing at 800°C for 3 hours. Microfractographic and microstructural analyses showed significant variations in the effect of hydrogen, depending on concentration. With 0.045% hydrogen by weight, an increase in cyclic durability was

recorded, while at higher concentrations, the reverse was observed. Vacuum had an important impact on fatigue resistance as well. X-ray analysis showed increased amounts of the beta-phase and microdistortion of the crystalline structure as hydrogen amounts increased from 0.003 to 0.2% in the alloy. Structural changes during annealing caused changes in durability and plastic properties, which improved up to 0.045%, after which a hydride brittle phase appeared. With the higher hydrogen content, the growth of flaws increased as hydride phases reduced adhesion between alpha-granules. The limit of hydrogen solubility in VT6 alloy was the point at which hydrides began to form and toughness began to decline. Figures 4; references 11: 8 Russian, 3 Western. [93-12131]

UDC 669.295-134:620.17

## DEPENDENCE OF MECHANICAL PROPERTIES OF LARGE VT3-1 ALLOY FORGINGS ON MICROSTRUCTURE PARAMETERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 84 (manuscript received 1 Jul 82) pp 126-129

KOLACHEV, B. A., GUS'KOVA, L. S. and VEYTSMAN, M. G., Moscow

[Abstract] For the purpose of more precisely classifying titanium alloys with respect to microstructure, specifically 100-300 kg large forgings of the VT3-1 alloy, mechanical tests and metallographic examination were performed on semi-finished specimens after isothermal annealing. Mechanical testing covered tensile strength, fatigue of cylindrical rods in pure flexure with rotation at 6000 rpm loading speed, and toughness of notched bars in eccentric tension. Metallography included macrostructural examination of templets cut from specimens before and after mechanical treatment as well as microstructural examination of fracture surfaces after failure in each test mode. On the basis of statistical analysis of the results, VT3-1 forgings have been classified into five structural groups: II) equiaxial fine-grain structure; III) fine-grain structure with oblong o -phase grains; IV) lammellar structure without visible β-phase grain boundaries; VI) lamellar structure with α-phase edging along β-phase grain boundaries, and VII) mixed. A poorly developed coarse structure remains outside this classification. A comparative evaluation of the results, taking into account the relevant statistical distributions, reveals that the fatigue strength increases and the toughness decreases with decreasing size of α-phase particles. References 6: all Russian. [102-2415]

UDC 669.295'292:536.42

PHASE TRANSFORMATIONS IN VANADIUM ALLOYS OF TITANIUM DURING QUENCHING AND TEMPERING

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 84
(manuscript received 14 Jun 82) pp 120-125

GUSEVA, L. N. and DOLINSKAYA, L. K., Moscow

[Abstract] An experimental study was made of phase transformation in titanium alloys with 10-22% vanadium during quenching and tempering. Specimens weighing 10-12 g were prepared from titanium iodide and vanadium by smelting in an open hearth in a helium atmosphere, with subsequent annealing and homogenization in vacuum at 900°C for 30 min. Quenching was done with icy water and with water at room temperature, tempering was done at 400°C for 150 hr. Hardness was measured with a Vickers tester; x-ray diffractometry was done in filtered radiation from a copper source using DRON-1 equipment with a scintillation counter. The periods of crystal lattices were also determined, taking into account the effect of phase diversity and dispersion as well as of stresses on the accuracy of this determination. The results, diffractograms and hardness readings taken over the entire test period, reveal that the α"-phase formed during quenching undergoes reverse martensite transformation during aging, that the ω-phase in all alloys increases to a certain concentration before splitting into an α-phase with 6% V and a β-phase with 33% V, and that the equilibrium solubility of vanadium in β-titanium is 50% at 400°C. The constitution diagram for the Ti-V system with ranges of metastable phase equilibria has been drawn on the basis of this study. Figures 4; references 10: 5 Russian, 5 Western.
[102-2415]

UDC 620.178:669.295

SENSITIVITY OF TITANIUM ALLOYS TO STRESS CONCENTRATION DURING REPEATED STATIC LOADS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 84
(manuscript received 25 Oct 82) pp 67-69

KUTEPOV, S. M., PLESHAKOVA, T. S. and RACHKOV, V. I., Moscow

[Abstract] Wide industrial uses have been found for OT4-0 and AT3 titanium alloys. The present article reports on their sensitivity to stress concentrations during static and repeated static loads. Studies were made on annealed sheets 6 mm in thickness. In static tear tests, the tested titanium alloys were not sensitive to stress concentrations, although the OT4-0 samples were more sensitive than those of AT3. Repeated tests also showed the titanium alloys to have little sensitivity to stress concentrations, except under extreme concentration circumstances. Figures 2; references 5: all Russian.
[93-12131]

UDC 669.2:539.214

CHANGE IN DAMAGE TO COLD DEFORMED ALLOYS DURING HEAT TREATMENT

Moscow TSVETNYYE METALLY in Russian No 3, Mar 84 pp 71-75

KOMOGOROV, V. L., BOGATOV, A. A., SMIRNOV, S. V. and GODIN, A. N.

[Abstract] Utilizing the phenomenologic theory of fracture, one can estimate the accumulation of damage during deformation and its reduction during subsequent heat treatment of materials. Equations are derived for the damage to metals accumulated by multiple-operation deformation with intermediate heat treatment. A method developed in an earlier work for determination of the critical values of accumulated damage is simplified and it is suggested that only standard testing equipment be used. The method is illustrated on the example of titanium alloy VT1-0 and the planning of a technology for manufacture of pipe with a guaranteed quality level in terms of continuity of the metal. The method for determination of the restoration of ductility during heat treatment after deformation can establish the critical values of accumulated deformation and kinetics of restoration of ductility, and can be used for estimation of the damage to metal after cold deformation. Figures 4; references 14: all Russian.
[95-6508]

UDC 669.295:292.018.2

IMPROVING MECHANICAL PROPERTIES OF CAST VT6L ALLOYS BY HEAT TREATMENT

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 84 (manuscript received 8 Feb 83) pp 83-86

BASTRAKOV, V. K., KOKNAYEV, R. G., TOMSINSKIY, V. S. and NEMANOV, A. M., Perm' Polytechnical Institute, Department of Casting Technology and Metal Science and Heat Treatment of Metals; All-Institute of Light Alloys

[Abstract] A study is presented of the influence of annealing on structure and properties of cast ($\alpha+\beta$) VT6L titanium alloy used for the production of complex-shaped castings. Studies were performed on alloys with various contents of carbon. Plates measuring 13 x 70 x 245 mm were cast in a metal mold in a type VDL-1 vacuum-arc furnace. Pipes were cut into standard specimens which were annealed at 950°C for 3, 5 and 7 hours, cooled with the furnace to 650°C, then cooled in air. Uniaxial extension and impact toughness tests were performed, as well as metallographic studies at magnifications of 100 and 1000 X. Annealing at 950°C did not change the strength of the specimens. It did increase the thickness of $\alpha$ plates and form a more uniform intragrain structure in comparison to the cast state. The changes were accompanied by an increase in ductility and impact toughness, particularly for the alloy with high (0.17%) carbon content. Figures 3; references 6: 4 Russian, 2 Western.
[97-6508]

UDC 669.295.3:620.181.4

INFLUENCE OF PRELIMINARY ANNEALING ON STRUCTURE AND PROPERTIES OF VT6 ALLOY AFTER STRENGTHENING HEAT TREATMENT

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 84 (manuscript received 2 Dec 82) pp 87-93

LYASOTSKAYA, V. S., KRASNOYARTSEVA, L. S. and FEOKTISTOVA, Ye. K., Moscow Aviation Technology Institute, Department of Metallography and Heat Treatment of Metals

[Abstract] A study is made of the influence of annealing before hardening and aging on the structure and properties of VT6 alloy with initial fine and large grain structure. Studies were performed on hot rolled bars 18 mm in diameter made according to the standard technology. Chemical composition was as follows, percent: 5.8 Al, 3.8 V, 0.04 Si, 0.02 C, 0.14 $O_2$, 0.01 $N_2$, 0.002 $H_2$. The $\alpha+\beta$ to $\beta$ transition point ($Ac_3$) of this alloy was 980°C. To produce a large grain material the bars of VT6 alloy were annealed at 1050°C for 2 hours with subsequent cooling in air and with the furnace to imitate various structural types. Specimens of VT6 with initial small and large grain structure were annealed at 800 to 1050°C for 1 and 5 hours with subsequent cooling in air and with the furnace to 450°C, further cooling in air. Specimens were hardened from 750 to 900°C after holding at the hardening temperature 40.5 hr, quenching in water. Hardened specimens were aged at 450 to 550°C for 4 hours. Preliminary annealing before hardening and aging produced a superior combination of mechanical properties and decreased variation in mechanical properties with all initial grain structures. Optimal mechanical properties were obtained by preliminary annealing of fine grain materials at 850°C for one hour, cooling in air, quenching in water from 900°C, 0.5 hr, aging at 540°C, 4 hr. Improved ductility in the thermally hardened state was obtained in specimens with initial large grain plate structure after preliminary annealing at 950°C, 5 hours, cooling with the furnace to 450°C, quenching in water from 800°C, 0.5 hr, aging at 540°C, 4 hr. Figures 4; references 5: all Russian.
[97-6508]

UDC 621.785.53

IMPROVING OPERATIONAL PROPERTIES OF TITANIUM ALLOYS BY DIFFUSION SILICIDING

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 84 (manuscript received 1 Mar 83) pp 94-97

LYAKHOVICH, L. S., BURNYSHEV, I. N. and VASIL'YEV, L. A., Belorussian Polytechnical Institute, Department of Metal Science

[Abstract] Diffusion siliciding has not been widely used with titanium. This work studies some properties of silicide coatings obtained by diffusion saturation in powders of silicon with intensifying additives. Diffusion siliciding

processes were accelerated by addition of copper powder at the saturation temperature of 850°C, 4 hours, producing silicide layers up to 100 μm thick. Siliciding in silicon powder without the addition of copper under the same temperature conditions achieves a layer thickness of only 10 to 15 μm. Coatings obtained at 850°C, 4 hours in a powder medium containing 87-77 mass % Si, 10-20 Cu and 3 $AlF_3$ were optimal from the standpoint of thickness of silicide coating and surface quality. Siliciding in silicon powder with copper as an intensifying additive thus allowed the production of siliciding coatings equal to or superior to the silicide coatings obtained without the intensifying additive. Figures 3.
[97-6508]

## LENIN PRIZE NOMINATION FOR WORK ON DIFFUSION WELDING OF METALS AND NONMETALS

Moscow VECHERNYAYA MOSKVA in Russian 23 Mar 84 p 2

[Article by A. Presnyakov]

[Excerpt] The signal 'instruments on' lit up on the control console. Tests of a new unit that is capable of joining together materials that cannot be joined--ceramic and titanium--were in progress. A vacuum pump began to pump air out of the unit. A button was pressed, and two plates--a ceramic one and a titanium one--were forced together by a press with a force of 500 kilograms. And then I held the finished part in my hand.

"We bond metals with ceramics, ferrites, quartz and glass with the aid of this automated unit," explained Professor N. F. Kazakov, head of a laboratory of the Aviation Technology Institute and a meritorious scientist and engineer of the RSFSR.

Dozens of certificates of invention and foreign patents have already been received for this process and equipment, which are the latest word in the welding industry. Scientists and engineers of many developed countries have recognized Soviet science's leadership in the field of diffusion welding of materials. This innovation has even been called 'Russian welding' abroad.

"Reserves of metals are not unlimited," observed N. F. Kazakov. "A number of machine parts of less critical importance can be made from ceramics, for example, in order to realize at least partial savings of scarce metals. Diffusion welding technology permits the bonding of ceramic with metal."

The first steps have already been taken toward the development of engines for motor transport and machine building which use ceramic parts.

A group of researchers headed by Professor N. F. Kazakov has been nominated for the 1984 Lenin Prize for "Development and broad industrial introduction of a fundamentally new method, process and equipment for diffusion bonding (welding) of metallic and nonmetallic materials".

FTD/SNAP
CSO: 1842/106

UDC 621.791:620.192.7-752.2.001.4:621.643

TESTING MULTI-LAYER EXTINGUISHERS OF EXTENDED TENACIOUS BREAKS IN MAIN GAS PIPELINES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 84
(manuscript received 18 Jul 83 in final form 19 Sep 83) pp 38-40

BILETSKIY, S. M. and TERESHCHENKO, A. F., candidates of technical sciences and BARVINKO, Yu. P., engineer, Institute of Electrical Welding imeni Ye. O. Paton, UkSSR Academy of Sciences; BOLOTOV, A. S. and MIROSHNICHENKO, B. I., candidates of technical sciences, All-Union Scientific Research Institute for Constructing Main Gas Pipelines; and ANENKOV, N. I., candidate of technical sciences, All-Union Scientific Research Institute for Natural Gas

[Abstract] Design of a multi-layer extinguisher of extended tenacious breaks in main gas pipelines has been described previously. The present article reports on study of internal hydraulic pressure and its impact on device function. The key feature of the extinguisher are the notches or baffles that distribute deformation between layers of the pipeline pipe wall. Pipeline sections were tested for failure by measured pressure increases. Significant variations in results were noted; these were attributed to mechanical variations in the steel used. Little difference was recorded in longitudinal and circumference pressure of test sections. The notches had no significant impact on static durability or strain distribution which were analogous to those for standard pipes. Figures 5; references 4: all Russian.
[91-12131]

UDC 621.791.4:539.378.3:[669.71+666.192]:531.31

KINETICS OF REACTION OF METALS AND NON-METALS DURING DIFFUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 84
(manuscript received 10 Dec 82, in final form 6 Sep 83) pp 25-27

BACHIN, V. A., candidate of technical sciences, Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy

[Abstract] Topochemical joining and substitution reactions that are fundamental to diffusion welding of metals and non-metals involve both soluble and insoluble products of reaction. Aluminum, magnesium, titanium, zirconium

and their alloys are known to react with most glass-like and ceramic materials to form such bonds. This happens through a substitution reaction that takes place with rapidity that differs for each concrete combination as the non-metal reaction products are dissolved into the metal. For example, silicon transforms into silica before bonding to aluminum. At the same time, some loss of tempering occurs, and mathematical calculations must be made to determine acceptable losses of durability for the sake of welded bonds. While substitution reactions must be stopped to prevent loss of temper, joining reactions form insoluble products that retard the reaction and cause it to cease. Figures 3; references 6: all Russian.
[91-12131]

UDC 621.791.4.011:539.378.3:620.192.7

## COLLAPSE AND REMOVAL OF DISCONTINUITIES IN JOINT ZONE DURING DIFFUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 84
(manuscript received 20 Dec 82, in final form 17 Oct 83) pp 28-30

GOSTOMEL'SKIY, V. S., candidate of technical sciences, and KARAKOZOV, E. S., doctor of technical sciences, Moscow Evening Metallurgical Institute

[Abstract] Quality joints require elimination of discontinuities, or pores. The present article reports on changes in the form of an individual pore and a group of pores during diffusion welding, in order to determine means of eliminating pores entirely. A mathematical presentation is given for the collapse of a thin disk perpendicular to the direction of compression as it collapses into the pore. Disk volume and dimension and the pressure applied are taken into consideration. Electrical resistance measurements at room temperature by a four-probe method, and metallographic studies were made on templates cut along the load line. Surface fractures in the plane of contact were studied with an electron scanning microscope. At times electrical resistance declined by jumps and pores took on toroidal forms; maintenance of load was subsequently followed by slight recovery of electrical resistance. Results confirmed earlier hypotheses that held that along with diffusion of the toroidal band into the surrounding material, the large radius of the pore grew at the expense of surface diffusion. Figures 2; references 12: 8 Russian, 4 Western.
[91-12131]

UDC 621.791.72:669.295

ASSESSMENT OF EFFECTIVENESS OF ELECTRON BEAM WELDING OF TITANIUM ALLOYS UP TO 40 mm IN THICKNESS BY VERTICAL OR HORIZONTAL BEAM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 84 pp 31-32

OL'SHANSKIY, doctor of technical sciences (deceased), LOPATKO, A. P. candidate of technical sciences, and PETRENKO, V. R., engineer, Moscow Power Institute

[Abstract] Use of electron beam welding has great promise for titanium alloys, but certain specific defects must be eliminated. The present article reports on vertical and horizontal electron beam welding of samples 5, 10, 15, 10, 30 and 40 mm in thickness at rates of 5, 10 and 20 meters/hour, with fixed focal length and height above the welded samples. Thin metals were welded effectively with either beam, but with thicker samples, energy consumption decreased 8--18% with the horizontal beam. Vertical welding required energy both for the melting operation and to reheat liquid metal that screened the beam. Vertical beams left a dagger-like seam profile, while horizontal electron beam welds had parallel walls. Microstructural changes were also less with horizontal beam welding, and plastic properties of seams were more regular. Figures 3; references 4: all Russian.
[89-12131]

UDC 621.791.011:669.788

DISTRIBUTION OF HYDROGEN IN MULTI-LAYER WELDED JOINTS OF ALLOYED STEELS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 84

MAKAROV, E. L., doctor of technical sciences and YEGOROV, N. I., candidate of technical sciences

[Abstract] The most common defects in welded joints of high-durability alloyed steels are cold cracks, including ones appearing as a result of emission of diffusion hydrogen. The present article reports on study to define the physical constants of the effective coefficient of hydrogen diffusion, initial diffused hydrogen content and transition of metallurgical hydrogen into the diffused form during heating. Heating was conducted in a staged manner from 100°C to melting point. Results showed the first transition of hydrogen at 200°C, with the most intensive transition during heating to 300-400°C. Hydrogen distribution was assessed using a non-isothermal two-dimensional procedure, which was used to develop an algorithm and a computer program starting with the seam crystallization stage. The mathematical model was tested experimentally with 14Ch2N3MA steel 40 mm thick, welded with various welding rods. Maximum concentrations of hydrogen and the time required for its accumulation were the basic parameters used to determine the likelihood of cold crack formation, with the time of increased hydrogen saturation another important factor. The calculations can be used to select materials and welding procedures that avoid accumulation of diffused hydrogen. Figures 6; references 9: all Russian.
[89-12131]

UDC 621.791.011

## WELDABILITY OF ALLOY ABM1 TO ALLOY 1201

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 84 pp 17-19

FOKANOV, A. N., KUZNETSOVA, Ye. A. and POPOV, V. D., engineers, and KUROCHKO, R. S., candidate of technical sciences

[Abstract] Design uses of ABM1 high-modular formed alloy components often require welding, but no studies have been made of procedures or results. The present article considers the effect of differing thermophysical characteristics during welding, heat adsorption and melt-resistant phases based on beryllium, the tendency of the other metal in many joints, alloy 1201, to lose temper when heated, and variations in hydrogen content in the two alloys. Automatic welding with an argon or argon and helium medium to prevent oxidation resulted in acceptable unoxidized seams, with base metal melting 2--2.5 mm from the welding zone. With thin 3-mm samples only a helium medium permitted satisfactory joints. Argon arc welding resulted in a much worse seam. Although the difference in the alloys complicated the test, x-ray pictures of the joints showed apparent flaws as the alloys mixed in the zones containing beryllium. Cracks appeared only at the beginning of seams. Impact strength, which was greater than that of alloy 1201, decreased by a factor of 2 in the melted area, but remained above that of alloy ABM1. Figures 1; references 5: all Russian.
[89-12131]

UDC 621.791.052.08:620.179.16:621.774.21

## ULTRASONIC LARGE-DIAMETER PIPE WELD TESTING INSTALLATIONS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 84 pp 40-42

SHEVCHENKO, I. Ya., BALDAKOV, V. F. and FILIPPENKOV, V. A., engineers, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] The authors' institute has developed and introduced two ultrasonic installations for testing of welded joint quality in large diameter pipes. The U-664 installation consists of two acoustical units placed symmetrically relative to the pipe being tested, and is capable of simultaneously testing both seams on 1200-1420-mm-diameter pipe at a rate of 20 m/min. The NK-105 unit is designed for testing of joints in 530-1220-mm-diameter pipe in sections 6 m in length. The device is a U-shaped structure with the acoustical head moving along a track while the pipe itself and the installation remain stationary. The use of the new devices can significantly improve the quality of gas and oil pipes. Figures 5; references 2: both Russian.
[99-6508]

UDC 621.791.4:539.378.3:[669.715+621.315.612]:620.18

# STRUCTURE OF TRANSIENT ZONE IN DIFFUSION WELDING OF TsTS-19 PIEZOCERAMIC WITH AMg6 ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 84
(manuscript received 6 Jun 83; in final form 6 Oct 83) pp 62-64

NOVIKOV, V. G., candidate of technical sciences, YEKIMOV, A. I., engineer, KRAVCHENKO, V. Ye., candidate of technical sciences, Krasnoyarsk Polytechnical Institute, KAZAKOV, N. F., doctor of technical sciences and BACHIN, V. A., candidate of technical sciences, Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy

[Abstract] A study is made of the structure of the transition zone of a joint between TsTS-19 piezoceramic and AMg6 alloy. Disk specimens 35 mm in diameter and 3-5 mm thick were welded on an SDVU-50 welding machine under a pressure of 7.5 MPa, temperature 793°K, residual gas pressure 1.33 Pa. Joint structure was studied under an optical microscope, by x-ray diffractometer and a microscopic analyzer. Diffusion welding was found to include solid phase reactions of reduction of lead oxide and diffusion of the components of the alloy, particularly the magnesium, into the ceramic. The transition zone is a two-phase system consisting of solid magnesium in the $Pb(ZrTi)O_3$ ceramic and elementary lead. Figures 2, references 10: all Russian.
[99-6508]

## GOALS OF NEW MATERIALS SCIENCE INSTITUTE DISCUSSED

Moscow KOMSOMOL'SKAYA PRAVDA in Russian 15 Apr 84 p 4

[Text] A new academy of sciences institute--the Institute of the Physics of Strength and Materials Science--has been established in Tomsk. Its director, corresponding member of the USSR Academy of Sciences V. Ye. Panin, commented on the institute's tasks:

"Our institute was organized on the basis of the department of solid-state physics and materials science of the Institute of Atmospheric Optics of the USSR Academy of Sciences' Siberian Branch, and the very fact of its creation points up the importance and current interest of the tasks set before us.

"Modern materials must function in quite unusual conditions--subjected to extreme temperatures, radiation, corrosive environments, and shock stresses. In many cases, the lack of high-strength materials for use in such conditions is holding back scientific and technological progress.

"Our goal is to develop high-performance materials. Directions such as the elaboration of physical principles of powder metallurgy and the deposition of powder coatings, the physics of strength, resistance of materials to cold and to wear and the physicochemical bases of technological processes for producing new materials for use in conditions of Siberia and the Far North will occupy a special place in our research."

FTD/SNAP
CSO: 1842/106

WOOD-POLYMER STRUCTURAL MATERIAL WITH HIGH WEAR AND HEAT RESISTANCE

Minsk SOVETSKAYA BELORUSSIYA in Russian 23 Mar 84 p 2

[Article by A. Gotovchits]

[Text] A new structural material developed on the basis of polymers and wood has become the thousandth invention of scientists of the Belorussian Academy of Sciences' Institute of Mechanics of Metal-Polymer Systems in Gomel'. This material does not swell in water, has high thermal stability and is resistant to wear.

"It can be used in place of bronze, cast iron and polymer materials in various industries, but particularly in the food industry and light industry, where ordinary lubricants obtained from petroleum cannot be used in rubbing joints of machines," related Doctor of Technical Sciences B. I. Kupchinov, one of the authors of this invention.

New production processes, composite materials, parts for machines and mechanisms and scientific instruments are among the institute's thousand inventions, the greater part of which appeared during the past decade. Most of these inventions are promoting higher labor productivity in the economy and the saving of material and energy resources.

FTD-SNAP
CSO: 1842/106

NEW MATERIALS-SCIENCE INSTITUTE DEVELOPS ALLOYS FOR EXTREME COLD

Moscow IZVESTIYA in Russian 1 May 84 p 3

[Article by L. Levitskiy, correspondnet (Tomsk)

[Text] The Institute of the Physics of Strength and Materials Science has been opened in the Tomsk affiliate of the Academy of Sciences' Siberian Branch.

The new institute's main task is to answer what would appear to be a simple question: why solid materials crack and crumble under large stresses. Contemporary theory that is based on the stability of crystals in metal does not reveal the causes of this.

"We are convinced that crystals are unstable," said V. Panin, corresponding member of the USSR Academy of Sciences and director of the institute. "By ascertaining the causes of deformations, we have learned how to predict the behavior of materials and design them with prescribed properties. Our scientists are collaborating with associates of Leningrad University and the Institute of Theoretical and Applied Mechanics of the USSR Academy of Sciences' Siberian Branch.

"Extra-strong materials that hold up at low temperatures have been made by the method of powder metallurgy. They are used to harden equipment, assemblies of earth-moving machinery, and tools. Inexpensive and readily available, these alloys are several times more durable than scarce and costly tungsten alloys. Rigorous tests of cutting tools clad in tungsten armor and of tools with an armor prepared by our scientists' technology were organized at a Tomsk plant. The latter armor proved to be eight to ten times as durable. The new alloy, in which special addition agents are used, is now being used exclusively for hardening purposes of this plant."

FTD/SNAP
CSO: 1842/106

NEW ROLLING MILL AT 'ELECTROSTAL'' PLANT

Moscow PRAVDA in Russian 3 May 84 p 2

[Article by G. Zazvonov, (Elektrostal', Moscow Oblast)]

[Excerpt] Workers of the "Metallurgprokatmontazh" Trust of the USSR Ministry of Installation and Special Construction Work have begun installing a new rolling mill at the "Elektrostal'" Plant imeni Tevosyan.

Improved performance qualities, including higher durability, will be realized in rolled metal products thanks to a three-roll stand which was developed by professors P. Polukhin and I. Potapov of the Moscow Institute of Steel and Alloys, in collaboration with designers of the production association "Elektrostal'-tyazhmash".

FTD/SNAP
CSO: 1842/106

'ISPARITEL'-M' SPACE METAL-PLATING UNIT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 13 Mar 84 p 4

[Article by G. Lomanov]

[Excerpt] Candidate of Technical Sciences V. Lapchinskiy, head of a laboratory of the Institute of Electric Welding imeni Paton, communicated with the crew several times before the beginning of an experiment.

"Don't worry; we're already sure that your unit is working excellently," flight engineer V. Solov'yev reassured him.

The crew has performed the latest series of experiments with a new unit, the "Isparitel'-M". It is intended for depositing metal and polymer coatings on various substrates.

The main working tool of the "Isparitel'-M" is an electron-beam gun. It shoots a beam of electrons at a refractory crucible filled with silver, copper, gold or a copper-silver alloy. This metal begins to vaporize and the vapors settle on a metal or glass plate, forming a mirror-like coating. Actually, only the unit itself can be called an innovation here; the letter "M" in its name stands simply for 'modernized'.

"What distinguishes the modernized variant of the 'Isparitel'', and what are its capabilities?"

"During the initial experiments, we wanted to ascertain that metal can be vaporized in space. After all, up until now work with melts in orbit has been done only in airtight capsules, but we are using an open crucible. I need hardly remind you that in zero gravity it is not easy to keep even ordinary water inside a glass. An experimental check made it possible to find an optimal shape for the crucibles and working heads and to make a number of improvements in the design of the 'Isparitel''.

"A wide range of applied tasks can now be accomplished with the aid of the new unit. The 'Isparitel'-M' can already deposit coatings as thick as tenths of a millimeter; its capacity is larger and its vaporization speed is higher. But its main feature is something different: this completely automated apparatus can perform eight different kinds of work. For example, neither metals nor plastics necessarily have to be deposited on glass or a metal plate, as was

formerly the case; they can also be deposited on a polymer film. Lastly, the unit has become a multi-purpose one; we can not only vaporize but also melt materials, as is done in the well-known space furnaces 'Splav' and 'Kristall'."

"You once said that the electron 'gun' could be converted into a 'pistol', with which a cosmonaut could work in space in approximately the same manner as a painter operates a hand paint-sprayer. Has this happened?"

"Yes, a series of experiments performed on board 'Salyut' stations enabled us to begin developing a versatile hand tool for space mechanics. Any metals and alloys can be cut, welded and soldered and thin-film coatings applied in open space with the aid of this tool. One variant of such a 'pistol' has already been perfected."

FTD/SNAP
CSO: 1842/106

ELECTRON DISCHARGE TECHNOLOGY FOR RECYCLING TUNGSTEN, TITANIUM WASTES

Frunze SOVETSKAYA KIRGIZIYA in Russian 28 Mar 84 p 3

[Article by R. Groshenkova]

[Excerpt] On the basis of developments of scientists of Kirgizia and in close collaboration with them, specialists of the Tula Ferrous Metals (Tulachermet) Research and Production Association have begun developing an experimental-industrial electron discharge unit for producing carbides of tungsten and titanium from wastes of these valuable refractory metals.

I asked Doctor of Chemical Sciences, Professor Usen Asanov: "Tell me, please, doesn't this involve developments of yours? As I understand it, in Kirgizia such research is done only at the Institute of Inorganic and Physical Chemistry."

"Yes, studies of the utilization of electron discharges in chemistry and chemical engineering have been in our laboratory since the 1970s.

"This direction is advancing successfully at our institute. Our practical recommendations in this field are protected by more than 30 certificates of invention."

"Why are the Tula specialists interested in techniques for the production of carbides, rather than any other compounds?"

"Our method is technologically simple, harmless and consumes little energy. But we have developed it only on the level of laboratory research."

"Why haven't you gone further?"

"We have no experimental facilities of our own. As a matter of fact, none of the republic's scientific research institutions specializing in chemistry have such facilities. Consequently, chemists do not carry their developments to the introduction stage in the majority of cases."

"How did they find out about your developments in Tula?"

"From scientific reports published in the press. The same way that these developments were learned about in Japan, France and Poland, from which we have

received requests to send published articles. A number of foreign firms have shown interest in acquiring licenses for the electron discharge unit for obtaining titanium and tungsten carbides. An application has been received from Hungary, in particular.

"Associates of the Novomoskovsk affilitate of the State Scientific Research and Design Institute of the Nitrogen Industry and Products of Organic Synthesis have also shown much interest in our work. They have developed the USSR's first experimental unit for obtaining active aluminum oxide by an electro-erosive (electron discharge) method. An experimental-industrial unit is being designed. V. D. Kondrashenko, the director of this affiliate, writes that developments of our institute are being used in the development and designing of these units.

"After an industrial unit has been developed, we hope that it can be used for the production of still other compounds that the economy needs."

"And do you have ties with enterprises of Kirgizia?"

"A method for utilizing metal wastes of industry has been developed from the Frunze Drill Plant. These wastes formerly were discarded. They contain valuable components, particularly high-alloy iron in the form of powders. Our method makes it possible to separate these powders and use them for producing machine parts by the method of powder metallurgy. The introduction of this method is planned, beginning next year."

FTD/SNAP
CSO: 1842/106

PRODUCTION OF BIMETALLIC MICROWIRE FOR ELECTRONICS

Moscow MOSKOVSKAYA PRAVDA in Russian 8 Apr 84 p 1

[Article by A. Ignat'yev]

[Excerpt] Wires that are manufactured at the Moscow Plant for the Processing of Special Alloys are finer than a human hair. A section which produces extra-thin wire for the electronics industry has been put into operation at this plant. This wire is made from alloys of extra-pure metals. A TASS correspondent was invited to a production line where wire made of so-called bimetals is drawn. A copper rod is inserted into a tall, thin silver 'cup' which is 12 centimeters in diameter. This blank is drawn out on several machine tools. As the size of these machines gradually decreases, the 'cup' is stretched out many kilometers. Its diameter is reduced to a few dozen microns. The wire is then flattened. "This wire is put into a transparent sheath at another plant," explained V. Chepelenko, deputy chief engineer. "A cable made up of such wires will be flat. Its width depends on the number of wires, while its thickness is quite small."

FTD/SNAP
CSO: 1842/106

ALLOY SUPERCOOLING ON 'SALYUT-7'

Moscow TRUD in Russian 11 Apr 84 p 4

MELENEVSKIY, I.

[Abstract] The article reports on photography and medical and materials-science experiments that were being completed by the Soviet-Indian crew at the conclusion of their mission on the orbiting station "Salyut-7". At the Flight Control Center, Candidate of Technical Sciences V. F. Lapchinskiy and Candidate of Chemical Sciences G. V. Zhukov commented on the materials-science experiment called "Pereokhlazhdeniye" (supercooling). They explained that in experiments on Earth with supercooling of a silver-germanium alloy, deep supercooling of the alloy had to be accomplished by melting one side of the alloy with a laser, while the other side was cooled with liquid helium. The product of this complex and costly process is a metal that holds up well to effects of radiation. Two examples of applications of such a product are said to be in walls of nuclear reactors, and in turbine blades of airplane engines. In the latter application, it is noted that a 100-degree increase in the temperature tolerance of turbine blades permits a 30-percent reduction in fuel consumption. The experiment was intended to demonstrate that the supercooling process can be accomplished more easily and less expensively in zero gravity. The experiment is said to represent an initial step toward the industrial production of superdurable materials capable of withstanding radiation and chemical stresses. Indian specialists are credited with preparing the alloy specimens for the experiment. An original method of heating them was proposed by scientists of the laboratory of experimental metallurgy in the city of Hyderabad. The "Isparitel'-M" unit in which the experiment was conducted was developed by the Ukrainian Academy of Sciences' institutes of electric welding imeni Paton, and electrodynamics.

FTD/SNAP
CSO: 1842/106

WORK ON CONTINUOUS STEEL MELTING, CASTING, ROLLING PROCEDURES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 15 Apr 84 p 2

[Abstract] The author reports on progress in developing new and more economical metallurgical processes and equipment for them. The utilization of continuous processes which lend themselves readily to mechanization and automation is called an important direction of this work. The author notes that attempts are being made in many countries to develop a continuous-action steel melting unit (SAND), and he claims that Soviet specialists have come the closest of all to solving this problem. He reports that a converter-type SAND has been developed at the All-Union Scientific Research, Planning and Design Institute of Metallurgical Machine Building (VNIImetmash) in collaboration with the Central Scientific Research Institute of Ferrous Metallurgy imeni Bardin. This unit has been incorporated in an experimental prototype with a productivity of approximately 10 tons of steel an hour. More than 50 melts have been accomplished and about 800 tons of metal have been melted in this unit. VNIImetmash has now developed an industrial SAND that is said to be capable of producing 200 tons of top-quality steel an hour, which makes it competitive with a conventional converter. The combining of continuous melting, continuous casting and continuous rolling of steel into a single flow is called the next step.

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SILICATE-MATERIALS R&D AT RIGA POLYTECHNICAL INSTITUTE

Riga SOVETSKAYA LATVIYA in Russian 8 Apr 84 p 2

MEZHINSKIY, G., Candidate of Technical Sciences, senior science associate

[Abstract] The author provides information on R&D activities of the chair of silicate technology and the problem research laboratory of glass and ceramics of the Riga Polytechnical Institute's school of chemistry. He notes progress has been made recently in expanding and modernizing the facilities of the chair and the laboratory, and in improving the organization of student research and strengthening the school's ties with industry. Research of the physicochemical properties of glasses, glass-forming systems and other silicate materials is called the main direction of student-faculty research in the chair and problem laboratory. Developments reportedly include temperature-stable electric insulating coatings for refractory metals, glass for light filters and lasers, and materials with special properties, including radiation-resistant and magnetoactive ones. The author reports that the institute's chemistry school now occupies a new building with up-to-date equipment and conditions for highly effective research work. The silicate-technology chair is said to be enrolling as many as 50 students a year. Mention is made of plans for opening an evening division of the chair, beginning in 1985.

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STEEL AND ALLOY INSTITUTE'S LASER METALWORKING PROGRAM

Moscow MOSKOVSKAYA PRAVDA in Russian 6 May 84 p 2

YEGIKOVA, V.

[Abstract] The article reports on the status and organization of laser metalworking research and training at the Moscow Institute of Steel and Alloys (MISiS). Work on the utilization of lasers in metallurgy is concentrated in the institute's problem laboratory on plastic deformation and hardening. This laboratory is headed by Doctor of Technical Sciences, Professor Vladimir Petrovich Polukhin, laureate of the USSR and Ukrainian SSR state prizes. A sector for laser treatment of metals was created recently in this laboratory. Candidate of Technical Sciences Anatoliy Nikolayevich Veremeyevich is the head of this sector. The sector has an industrial laser which was developed by the Institute of Atomic Energy imeni Kurchatov. Polukhin is quoted in regard to his laboratory's ties with industry and problems of expanding the training of laser metalworking specialists to meet industry's needs. He mentioned the Rustavi and the Novolipetsk metallurgical plants among the enterprises which have shown an interest in MISiS' laser metalworking research. The problem laboratory is cooperating with the institute's chairs of physics, roentgenography and physics of metals, and plastic deformation of special alloys. Students take part in the laboratory's work chiefly as members of a student design-and-technological bureau (SKTB), which is headed by senior engineer T. A. Bochkareva. S. I. Pedos, a docent, directed a project of two students entitled "Utilization of Laser Radiation for Hard-Facing With Powder Materials", which won first prize in an institute scientific competition among students. Lopukhin explained that the USSR Ministry of Higher and Specialized Secondary Education as yet has not established a laser metalworking specialization for an undergraduate degree. He noted the Moscow Higher Technical School imeni Bauman has started a program of laser technology training. The chair of instruction in charge of this program has an orientation toward machine building industries. The type of laser specialist MISiS seeks to train is oriented toward metallurgy. MISiS does have a special school for retraining of industrial personnel in a laser technology specialty. With the assistance of the institute's scientists, students in this school do diploma projects which have a practical application for plants which send them for the retraining program. Such laser technology retraining programs exist at several other higher educational institutions. But Lopukhin says it makes more sense to establish the laser technology specialty at the undergraduate level. He urges the education ministry and the State Committee for Science and Technology to consider this.

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SOLAR METALLURGY RESEARCH AND PRODUCTION COMPLEX NEAR TASHKENT

Moscow PRAVDA in Russian 18 Apr 84 p 6

ANDROSHIN, A.

[Abstract] The article reports on a solar metallurgy research-and-production complex which is under construction in the foothills of the Tyan'-Shan' mountains, near Tashkent. Called "Solntse" (sun), the complex is intended for working out solar-furnace technology of producing superpure, highly refractory materials on an industrial scale, figuring in amounts of hundreds of tons. The scientific director of the complex is S. A. Azimov, member of the Uzbek Academy of Sciences and director of the Physical-Technical Institute imeni Starodubtsev. In the complex, the sun's rays will be reflected onto the mirrors of a solar concentrator by 62 heliostats. Each heliostat has a mirror about 50 square meters in area. Arranged in checkerboard pattern on concrete terraces, the heliostats are equipped with electric drives for zenithal and azimuthal rotation. Each has its own trajectory of movement. Computer calculations of the optimum arrangement of the heliostats were made by scientists of the Physical-Technical Institute, with the help of specialists of the State Optics Institute imeni Vavilov. The concentrator's mirrors will gather the reflected rays into the focus of a solar receiver with a concentration power of tens of thousands of times. The temperature in the focus of the receiver, which is the solar furnace, will exceed 3,500 degrees Celsius. Among other organizations taking part in the project is the All-Union Scientific Research, Planning and Design Institute of Metallurgical Machine Building. It is noted that all of the complex's buildings and structures are being erected on the basis of earthquakeproof designs.

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ELECTRON-DIFFRACTION STRUCTURAL EXAMINATION OF AMORPHOUS IRON-TIN ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar-Apr 84 (manuscript received 2 Dec 82) pp 173-179

ZHUKOVA, L. A. and POPEL', S. I., Sverdlovsk

[Abstract] A structural study of amorphous iron-tin alloys was made by the electron-diffraction method, amorphous alloys having been found to excel their crystalline counterparts in some performance characteristics. Film specimens containing 31--50 atom.% Sn were produced by the vapor deposition process on colloidal substrates under a vacuum of $6.8 \cdot 10^{-2}$ Pa, with a heavy copper plate serving as heat sink. Electron diffractometry was performed immediately after deposition at room temperature and after soaking at 473°K for 1, 2, 5, 10, and 20 min, before crystallization of the inherently unstable films occurred. The pattern of diffraction peaks reveals a polyphase structure, no one phase having formed alone because of insufficiently fast cooling. Bifurcation of

the first corresponds to an iron-rich phase and a tin-rich phase, both amorphous. Both peaks shift toward shorter wavelengths with longer soaking time, while their amplitudes also change: that of the iron-rich phase decreasing and that of the tin-rich phase increasing. The following diffraction peaks are either also split or asymmetric. The difference functions characterizing the radial atom distribution, calculated by Fourier analysis of the structural-parameter curves on a YeS-1033 Unified System computer with exclusion of spurious ripples caused by discontinuities at finite values of the diffraction parameter, reveal no intermetallic compounds ($Fe_3Sn$, $Fe_3Sn_2$, FeSn, $FeSn_2$) appearing in the process of equilibrium crystallization. The peaks of these difference functions split into two for the Fe-(31 atom.%) Sn alloy and into three for the Fe-(50 atom.%) Sn alloy. Calculations of interatomic distance and coordination number according to the Vegard rule yield data on both β and β' tin phase, indicating a distorted β-Sn(β') structure with higher symmetry than in crystalline alloys and a redistribution into a β-Sn structure during soaking within 20 min. Figures 4; references 9: 6 Russian, 3 Western.
[102-2415]

UDC 539.374

BENDING TWO-LAYER METAL-POLYMER PLATES

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 84 (manuscript received 1 Dec 82) pp 100-104

STAROVOYTOV, E. N. and STAROVOYTOVA, T. A., Gomel' Polytechnic Institute

[Abstract] Laminated plates and covers usually consist of materials with strikingly different physicomechanical properties, with highly durable, stiff bearing layer and softer materials for monolithic balance, force distribution, and protection from external forces. The present article discusses procedures required in selecting materials to perform prescribed functions. The theoretical model is based on a thin metallic bearing surface and a soft polymer that is resistant to deformation. Consecutive linear approximations are used to combine methods for physically nonlinear media and irregular thermoviscosity. Universal nonlinear functions and rheonomic characteristics are plotted for polytetrafluorethylene (Fluoroplast-4) and an aluminum alloy, in the form of a rectangular two-layer plate with free support on the edges. Computer processing made it possible to produce a mathematical solution to a problem of linear viscous resilience theory, although hydrostatic stress was not considered. Figures 3; references 13: all Russian.
[93-12131]

UDC 620.178.38:539.43

EFFECT OF STRESS CONCENTRATION ON FATIGUE RESISTANCE OF REFRACTORY NICKEL ALLOYS UNDER ASYMMETRICAL MULTICYCLE LOADING. COMMUNICATION 1

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 84
(manuscript received 25 Oct 82) pp 61-67

SINAYSKIY, B. N., Mechanics Institute, UkSSR Academy of Sciences, Kiev

[Abstract] Sharp variations in cross-section of manufactured parts result in local stress increases. In turbines such stress concentrations occur in the transition from blade to shaft and in areas of corrosion and erosion damage. Earlier research had shown that under cyclic stress, nickel alloys display sensitivity to stress concentrations. The present article reports on a series of studies of cyclic and static loads in rolled EP109 and cast ZhS6U nickel alloy products. Experimental data served as starting information for evaluating the effects of stress concentration on fatigue in refractory alloys at various cyclic assymetries and configurations of stress limit diagrams in smooth and notched samples. Analysis of the data presented showed that fatigue and wear life of the tested alloys fit well into the logarithmic coordinate system. Fatigue fractures were found to appear in both tested alloys at 800°C in a plane of stretching stress. Alloy type and amplitude coefficient were of importance, and wear life of little significance, in determining resistance to cyclic and static loads. Fatigue resistance in ZhS6U samples with circular notching was 5-40% higher than for EP109, while in smooth samples, fatigue resistance in the ZhS6U was 30-80% less than for EP109. Figures 6; references 13: all Russian.
[93-12131]

UDC 669.295:669.14.018.295

MECHANISM OF TITANIUM IMPACT ON BRITTLE TENDENCY IN DELAYED DEFORMATION OF MARTENSITE-AGING STEELS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, Mar 84 pp 53-55

KARDONSKIY, V. M. and GORBUNOVA, N. B., Central Scientific Research Institute for Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Previous studies have shown that hydrogen can combine with titanium in a solid solution and remain there despite dehydrogenization processes wherein titanium atoms are transformed from solid solution to the intermetallide form during aging. Tests have shown that adding aluminum can compensate for loss of titanium during the aging process, when at temperatures of 400-450°C, particles with the form $Ni_3Ti$ are emitted. This process of hydrogen brittleness and its relation to the second phase during aging are described in detail. Figures 1; references 8: all Russian.
[87-12131]

UDC 669.35'15'245'255'715'74:669.017.3

EFFECT OF FORM MEMORY IN ALLOYS BASED ON Cu-Al SYSTEMS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3 Mar 84 pp 47-50

TITOV, P. V., Institute of Metal Physics, UkSSR Academy of Sciences

[Abstract] Numerous alloys with form memory are used for various technical purposes, but few have been studied thoroughly. The present article reports on study of aluminum-bronze properties such as brittleness and, with ca.14% aluminum, low thermal durability. Addition of nickel, manganese, cobalt or iron results in heat-sensitive alloys with numerous uses. Alloying of Cu-Al containing 13-14% Al with 1-2%Co, Ni or Mn reduces hysteresis by a factor of 2, while 4-5% nickel content reduces it by nearly 4 times, to 10-12°C. The nature of form memory relative to cooling and heating is discussed. Reversible plastic deformation is connected to twinning and reorientation of unfavorably oriented martensite crystals. Reversible form changes in Cu-Al alloys can be encouraged by thermal processing. Reduced ability to recall form is attributed to irregular particles in the $\beta_1$-phase. Titanium nickelide alloys with good corrosion resistance and electrical resistance are compared to aluminum bronze in terms of form memory and its longevity. Figures 4; references 11: all Russian.
[87-12131]

UDC 621.039.3

ELECTRON-PLASTIC EFFECT IN METALS

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 84
(manuscript received 18 Jul 83) pp 103-106

TROITSKIY, O. A., Institute of Physical Chemistry, USSR Academy of Sciences

[Abstract] This is a survey of research in electron-plastic effects in metals. V. Ya. Kravchenko made a theoretical study of dislocations caused by electrical current and its retardation by conductive electrons. The electron-plastic effect (EPE) presumes the presence of electron-dislocational and drifting electrons reacting with dislocation "stoppers." A different viewpoint gives emphasis to the effect of temperature gradients on plastic deformation of metal, despite a lack of experimental evidence. Some authors failed to show their methods for controlling temperature even when attempting to demonstrate the importance of temperature on metal shaping. Others have neglected to describe all instrumentation and side effects in their study of the mechanism of high-intensity current on plastic deformation. Still others relate the Ampere law to distortions, even though the resulting sudden shifts have nothing to do with EPE. The failure of another study to find EPE in lead is attributed to the fact that at the given temperature of 4.2°K, lead is in a superconductor state. In summary, the author stresses the failure of various authors to consider the electron-plastic effect as an independent physical phenomenon. References 20: 14 Russian, 6 Western.
[92-12131]

UDC 620.171.3:620.178.15:669.3

EFFECT OF TEMPERATURE AND DEFORMATION RATE ON HARDNESS OF COPPER

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 84
(manuscript received 5 Jul 82) pp 52-55

KRASHCHENKO, V. P. and OKSAMETNAYA, O. B., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Despite its effect, many authors do not present data on the time of deformation in reporting research on hardness. The present article reports on the rate of indentor operation at various temperatures and its effect on hardness. Thermodynamic activation analysis of shaping of pure copper at 0.25-0.9 of the melting temperature was made after annealing at 823°K in a vacuum chamber at less than 0.7 MPa for 1 hour. Rate of deformation was defined as a ratio of the degree of plastic deformation to the time of indentor penetration into the sample. Results showed that the hardness of the copper decreased in inverse correlation to the rise in temperature, while increasing the rate of deformation increased the level of hardness without changing its character. The temperature at which dislocational slippage changed into dislocational creep shifted into a higher temperature range as the rate of deformation increased. Changes in hardness and durability were subject to the exponential law, and in the dislocation creep (high temperature) range, self-diffusion takes place along dislocations caused by deformation. Figures 2; references 13: 10 Russian, 1 Ukrainian, 2 Western.
[92-12131]

UDC 546.26:629.18:539.401

EFFECT OF MACROSTRUCTURE ON DURABILITY OF POLYCRYSTALLINE GRAPHITE

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 84
(manuscript received 27 Oct 82) pp 50-52

KOTOSONOV, A. S., LEVINTOVICH, I. Ya., VOLGA, V. I. and KALUZHSKIKH, N. F., Moscow

[Abstract] Producing construction graphite with predetermined durability requires knowledge of the interrelation between durability and structural defects. Micro- and macrostructural faults and porosity have been considered in previous studies. The present article reports on comparison of strength limits during flexing and characteristics of micro- and macrostructure by study of VPP hardened coke prepared in a variety of ways. Electronic properties and ductility were assessed to determine structural features. Results indicated that microstructural features, as shown in magnetic resistance and paramagnetic receptivity, were not tied to durability. The development of macrofissures and damage by destructive loading were macrostructural factors that contributed to failure, and the coefficient of ductility was found to be a useful parameter for predicting durability of graphite products. Figures 2; references 11: 9 Russian, 2 Western.
[92-12131]

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